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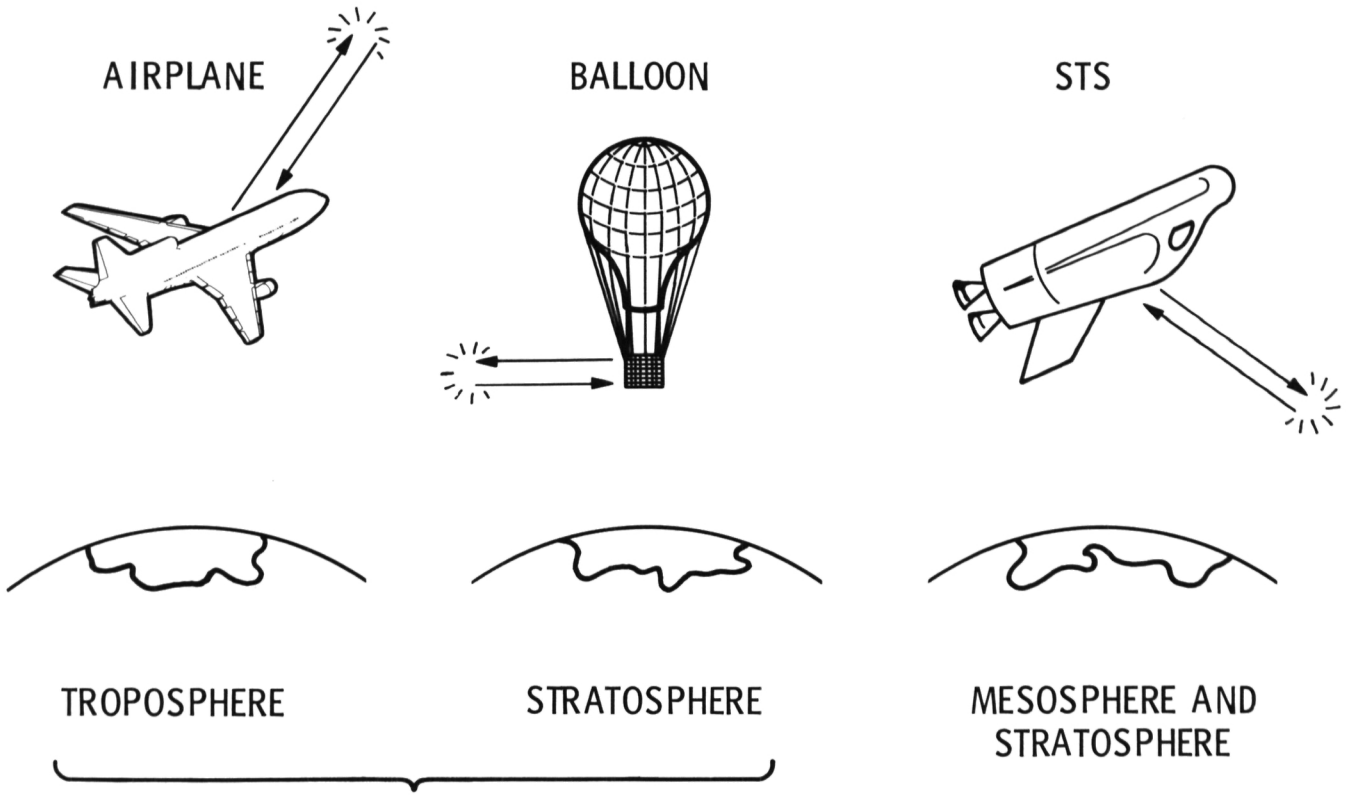
DEVELOPMENT OF AN ULTRAVIOLET EXCIMER LASER FOR ATMOSPHERIC SENSING

The oxygen-hydrogen radical plays a key role in the chemical cycles involving the formation and destruction of ozone; therefore, it is of vital importance for the understanding of chemical models of the atmosphere to have good measurements of the OH concentration profile. Even though the OH radical is important in atmospheric chemistry, it is present in only trace amounts, which makes detection by conventional sensing methods difficult.

Laser fluorescence remote sensing methods have proven to be a specific, extremely sensitive technique to measure concentration profiles of trace species. Until recently there was a scarcity of high-energy tunable laser sources in the ultraviolet needed to detect OH molecules.

At JPL a high energy xenon-chloride excimer UV gas laser was developed and demonstrated with a wavelength gain region from 3073.8 to 3085.7 angstroms, where several OH absorption lines are known to lie. Because the UV laser pulse can lead to chemical formation of OH in the troposphere. JPL researchers developed simple techniques to extract the energy from a XeCl laser in a subnanosecond pulse with high efficiency. The shorter pulses eliminate the artificial OH generation problem that has plagued other attempts at laser measurement of OH in the troposphere.

In separate experiments the collision-free radiative lifetimes for the fluorescent state of OH excited by the XeCl laser pulse were measured, along with the quenching rate constants from excited states with various atmospheric gases, including nitrogen, oxygen, and water molecules. These radiative and quenching rates are necessary to calculate the fluorescence efficiency or how many photons are emitted back to the detector compared to the number of photons absorbed by OH during the laser pulse. The XeCl excimer laser development for OH detection can be applied to laser sensing of other molecules at other wavelength regions in the ultraviolet.



Laser remote sensing of the upper atmosphere.